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Gender Differences with Regards to Interest in STEM (Evaluation)

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Gender Differences with Regards to Interest in STEM (Evaluation)

Introduction

In an era of reform, Science, and Technology. Engineering, and Mathematics (STEM) education is a hot topic in preparing students for the jobs needed in the twenty-first century [1]. According to one study, students with positive experiences in primary education STEM subjects are more likely to pursue STEM at a different level [2]. In addition, females have a much lower representation than males do across typical STEM subjects. Learning STEM subjects is a pathway to good jobs, and those jobs are important to the American economy [4].

Achievement gaps in STEM among gender groups and the underrepresentation of females in these fields should be addressed if the United States is to meet its educational goals [3]. Over the past thirty years, women have made substantial educational gains in male-dominated STEM fields and careers. However, a gender imbalance still remains. Females are still largely underrepresented in the fields of STEM despite the large documented earnings gained from holding STEM degrees [7].

This study will discuss the factors that influence the levels of interest in the fields of STEM among high school and middle school students. Data was reported from the results collected during five summer engineering camps held at a local university as part of the Department of Education's Gaining Early Awareness and Readiness for Undergraduate Programs (GEARUP) program. The camps were intended to help increase interest in STEM careers and STEM postsecondary education among middle and high school students. The weeklong summer camps were held in the years 2017, 2018, 2019, 2022, and 2023. Two years were skipped due to the COVID pandemic. Being able to discover which factors influence these students, not only males but females, can help gain an understanding of what is needed to promote interest in different STEM fields and help fill the demand of the workforce.

Program Description

Students and teachers coming from multiple school districts in (state in the mountain west region) were invited to attend a week-long summer engineering camp. Those camps happened in the summers of 2017, 2018, 2019, 2022, and 2023. Two similar camps was scheduled for the summers of 2020 and 2021 but were cancelled due to the pandemic.

The camps were designed for the purpose of increasing student interest in STEM. The camps are part of a 7-year grant funded by the Department of Education as part of the GEAR UP program. The overall goal for the grant was to help more than 3,000 middle and high school students to improve their academic achievement, creating a pipeline of academically prepared students enrolling and excelling in college in STEM related endeavors. During the summer camps, teachers and students participated in a variety of engineering activities. During those camps, they developed research hypotheses, proposed methods to test those hypotheses, and overall thought like engineers. Teachers who participated applied the research and engineering camp activities to develop future classroom lessons for their classrooms to meet the Next Generation Science Standards (NGSS) framework which had engineering as a main component. The number of participating students in the 2017 camp was 33 and the number of teachers was 10. For the 2018 and 2019 camps, the number of participating students was 44 and the number of teachers was also 10. A few of the students were returning and have attended previous camps, but for most, it was their first camp of the sort. This paper builds on previous work by the same researchers [8]. Participant demographics for student participants is shown in Table 1 below.

Table 1. Demographics of student participants

Category	Number (Percentage)
Age in years	N (%)
14	43 (29.1%)
15	50 (33.8 %)
16	28 (18.9%)
17	27 (18.2%)
Sex	N (%)
Male	85(57.4%)
Female	62 (41.9%)
Non-Binary	1 (0.7%)

For the five camps, students ranged from 14-17 years old, with eighth graders going into ninth grade attending the 2017 camp, ninth graders going into tenth grade for the 2018 camp, and tenth graders going into eleventh grade for the 2019 camp. Finally, juniors attended the 2022 and 2023 camps. The distribution of sexes was almost even with 57.4% male and 41.9% female and one non-binary student.

The program was designed to promote hands-on learning and minimized passive classroom learning. The main theme of the three engineering camps was water and environmental engineering. The 2018 camp specifically included advanced water engineering with drones used in agriculture and air quality engineering. Before the camp activities started, students completed a pre-camp survey to determine what their perceptions of and interest in STEM were, as well as the factors influencing that interest. The same survey was given to students at the end of the camp to determine how the camp experience had influenced the students' perceptions and interest in STEM, as well as examine which factors influenced that interest. This research focused on the differences between males and females in terms of the factors influencing their interest in STEM fields.

Below is a description of activities that the students and teachers were involved in during the 2017, 2018, 2019, 2022 and 2023 camps. After the description of each activity, sample quotes are included. These quotes were taken from the journals students wrote in at the end of each day.

Engineering Camp 2017:

During the **first** day of the engineering camp, activities were included to pique the students' interest in using STEM activities to better manage water resources. To begin the day, they started with an activity showing students the water cycle and illustrated the amount of available fresh water for human use. This was done in the hope of increasing their appreciation for the scarcity of usable water. The results of this activity showed up many times in the students' daily journals in which they wrote that they learned more about the importance of water conservation. Following the water cycle activity was a fish tagging activity. This included how the fish tagging works, the importance of it, and how scientists and engineers use the process to determine the health of streams and movement of fish in the stream. Thanks to the aid of a graduate student in Fisheries Biology, students had the opportunity to engage in the practice of tagging fish.

During the **second** day of the engineering camp, students visited three sites along a river in a local water shed. Their first stop was upstream in the mountains where the river is fed from melting snow. The next stop was downstream of camping, fishing, kayaking and other recreational uses of the water at a point just before the river enters the city. The last stop was after the river had passed through the city, farms and ranches in the area. For each stop, students took various physical and chemical measurements of the water including temperature, flow velocity and volume, dissolved oxygen, turbidity, and nutrient concentrations including phosphates and nitrates. These students also collected and characterized macro invertebrates living in the river. The reason for this activity was to show the students what actually happens physically, chemically, and biologically to the water as it flows downstream, passes through a city, and changes in response to the influence of human activity. Also included in the day's activities was a hike to a beaver dam.

The **third** day of the engineering camp focused on the impacts of storm water as well as water treatment. This included a simulated storm water activity comparing run-off volume and intensity as rainfall was simulated on an area covered in vegetation and another area covered with asphalt/concrete to show the potential impact of urban development (increases in impervious surface areas). Students then visited a parking lot storm water system at a local chain box store and observed the plants used to filter pollutants running off of the parking lot such as gas/oil. Those pollutants get washed away by the rain, but before the water entered the storm water system, it passed through this thick vegetation area and is cleaned by the specialized plants. Students also had the opportunity to see what happens as a non-reactive fluorescent tracer (simulated pollution) was dumped into the local river and observed how fast and how far pollution can spread. Finally, teams of students competed at building a water filter from sand and gravel. Faculty and student researchers judged the quality of the filters based on the clarity of the filtered water as well as the speed at which the filter worked.

On the **fourth** day of the engineering camp, focus was on wastewater treatment plants. Students looked at bacteria under the microscope and saw some of the bacteria that are at work at biological treatment plants. After learning about bacteria related to treatment plants, students visited a local treatment lagoon and wetland system that filters water of the surrounding county. Students then sampled and analyzed water quality parameters at a mechanical treatment plant. Students then learned the differences between the two treatment methods, natural and mechanical, as well as the advantages and disadvantages of both methods.

For the **final** day, Day 5 of the engineering camp, students presented what they had learned with a poster session followed by a presentation session. And lastly, students completed a post survey to gauge their learning and what had changed with their perceptions of STEM.

Table 2 shows a summary of the activities students and teachers engaged in during the week-long engineering camp in 2017.

Table 2. Summary of Activities for the 2017 Camp

Day	Activity 1	Activity 2	Activity 3	Activity 4
Monday	Water cycle	Fish tagging		
Tuesday	Measuring water properties at multiple locations along a local river, starting upstream and then going all the way downstream			
Wednesday	Water run off experiment	Storm water impacts/multiple locations	River dye activity	Building and testing a water filter
Thursday	Looking at bacteria under a microscope	Site visit to local lagoon treatment facility, sampling and analysis of water quality parameters	Site visit to local mechanical waste water treatment facility, sampling and analysis of water quality parameters	
Friday	Poster session	Presentation Session		

Engineering Camp 2018 and 2019

Camps in 2018 and 2019 were structured differently than the 2017 camp. Instead of all the students and teachers working together all week, the students were split into four groups, and aside from the first and last day, each group was doing different activities each day. The groups rotated through four activities during the week, in which all students experienced all the activities. This allowed for more interaction with the engineering faculty, graduate students, and undergraduate students that facilitated the camp.

For the **first** day of the camp, students filled out a pre-survey similar to the 2017 camp, and then attended a short presentation by each of the facilitators of the activities to pique the students' interest and prepare them for what they would be doing for the rest of the week. After that, the groups of students participated in assembling simple submarines/submersible ROVs (Remotely Operated Vehicles) to use during the week to check water parameters, such as temperature and turbidity (water clarity) as well as take underwater videos.

The **second** and **third** days of the camp involved students participating in all four activities described below. The activities were:

- **Sea Perch Submarines:** The students took the submarines they had assembled the day before to a dam reservoir on the local river to collect water samples, gather a variety of data, and take underwater videos using Go Pro cameras. They could maneuver the submarines to different locations in the water using their remote controllers.

- **GIS Stream Data:** The students went to a stream to collect data on the water depth and water flow at multiple locations. The students looked at water characteristics as well.

- **Air Quality/Drones:** The students learned about air quality and then measured the air quality using two different methods. The first method was using a sensor with a LED light that changes color based on the amount of pollution in the air. The second method was flying a drone that had multiple sensors to measure the air quality.

- **Flying Aggies:** Students learned that farmers can use drones that take pictures to improve their fields.

The **fourth** day: The students picked one of the four activities they had done during the previous two days to do more involved research, spending a full day on the topic. This put the students into groups according to their selected activity where they developed a research question, collected data, and analyzed that data.

During the **final** day (Day 5) of the engineering camp, the students participated in a research poster session followed by a research presentation session. At the end of the camp, the students completed a post survey to see how their perceptions of STEM had changed or not changed. Table 3 below shows a summary of the activities students and teachers engaged in during the week-long engineering camps in 2018 and 2019. All of the groups had slightly different schedules, but they all participated in the same activities. Below is the schedule of one of the groups.

Table 3. Summary of Activities for the 2018 and 2019 Camps

Day	**Activity 1**	**Activity 2**
Monday	Presentations summarizing the activities for the week	Building submersible ROV's
Tuesday	Sea Perch Submarines	GIS Stream Data
Wednesday	Air Quality/Drones	Flying Aggies
Thursday	Activity Choice	Working on Poster and Presentation
Friday	Poster and Presentation Sessions	

Engineering Camp 2022 and 2023

Following the Covid 19 pandemic, the camps were restructured, and the 2022 and 2023 camps became two days long, unlike the five-day long previous ones. Those two camps focused on rocket design and launching activities. In both camps, the first day, the student designed and launched water rockets. They learned how the ratio of air and water in a bottle affects the effectiveness of the rocket. Each group did multiple test launches to understand the effect of said ratio of performance.

Data Collection

Students' Pre and Post Surveys

During the students' first day at the engineering camp, they took a pre-camp survey. This survey included the STEM-CIS (Career Interest Survey) based on the work of Kier, Blanchard, Osborne, & Albert [7], as well as demographic information. The STEM-CIS consists of 44 questions that were based on a 5-point Likert scale ranging from 'Strongly Agree' to 'Strongly Disagree'. Four sets of 11 questions were made from 44 questions based on the four areas of STEM. An example question was *"I believe engineering is important"*.

An additional four questions were in the pre-camp survey based on the work of Talton and Simpson [8]. These questions were in the form of a 5-point Likert scale that examined peer perceptions of science. An example question was, "*My best friend likes science".* A final component of the pre-camp survey was questions related to students' informal prior experience with STEM based on the work of Franz-Odendaal, Blotnicky, French, & Joy [9]. An example of a question was, "*Which of the activities listed below have you participated in in the past year? (You can choose more than one)"* The responses to the questions looked at the following degrees of engagement: *No STEM engagement, low level of STEM engagement, moderate level of STEM engagement, and high level of STEM engagement.*

Following the camp, a post-camp survey was given that was the same as the pre-camp survey. The post-camp survey included additional questions asking the students to rate the activities they participated in during the camp. Qualitative data was collected through the pre- and post-camp surveys and the daily journals students kept. Example questions to collect qualitative data were, *"Are you interested in STEM (Science, Technology, Engineering, and Mathematics) career? Why or why not?", "What is your perception of STEM careers and their importance?",* and *"What made you choose to come to this camp?"*

Data Analysis

The students were mostly from low-income families. The high initial interest and low-income show that the sample is not representative of the State's population or the population of the United States. Therefore, instead of drawing conclusions about the population as a whole [10], conclusions are drawn from the differences between male and female interest in STEM.

The qualitative data analysis was split between male and female. The data was read by the faculty advisor and two undergraduate students. The group decided on common themes in the data and was then coded by the two undergraduate students using software MAXQDA. The two undergraduate students were advised on how to do qualitative coding by a faculty advisor. The coding was informed by, *The Coding Manual for Qualitative Researchers* by Saldana [11] and *The Qualitative Inquiry and Research Design* book by Creswell [12].

The two undergraduate students looked through all of the data first to decide what main coding themes to use. The main themes were: *Educational Experiences, Interests, Future,* and *Relationships/People*. The two students went through the first coding cycle by themselves and then met to arbitrate and come to an agreement about codes were there was a disagreement. Once agreements were made, the students decided on sub-themes, and came to agreements during the second cycle of coding. The target was an interrater reliability Cronbach's Alpha of 0.8 [13]. In both, the first and second cycle of coding, the interrater reliability exceeded 0.8.

Afterward, the qualitative was analyzed based on the recommendations from the literature about mixed methods research, such as Creswell's book, Designing and Conducting Mixed Methods Research [14].

Results

Qualitative Data

During the coding process, four major themes were found, General Interest, Relationships, Future Opportunities, and Previous Experiences. The results of coding with respect to gender differences are shown in Table 1, while Figures 1 and 2 present the data in graphical form. Figure 1 is the raw tally of themes (main-themes and sub-themes) from participants. Figure 2 is important because the raw tallies can be misleading if taken at face-value since are 85 male participants and only 63 female participants. For example, in the main-theme 'Experiences' there were 139 mentions by females and 145 mentions by males. But Figure 2 makes it clear that percentage-wise, females valued 'Experiences' more since the 139 responses were 25.3% of the total responses by females whereas the 145 were 20.7% of the total responses by males. The same observation is true of other main-themes and sub-themes.

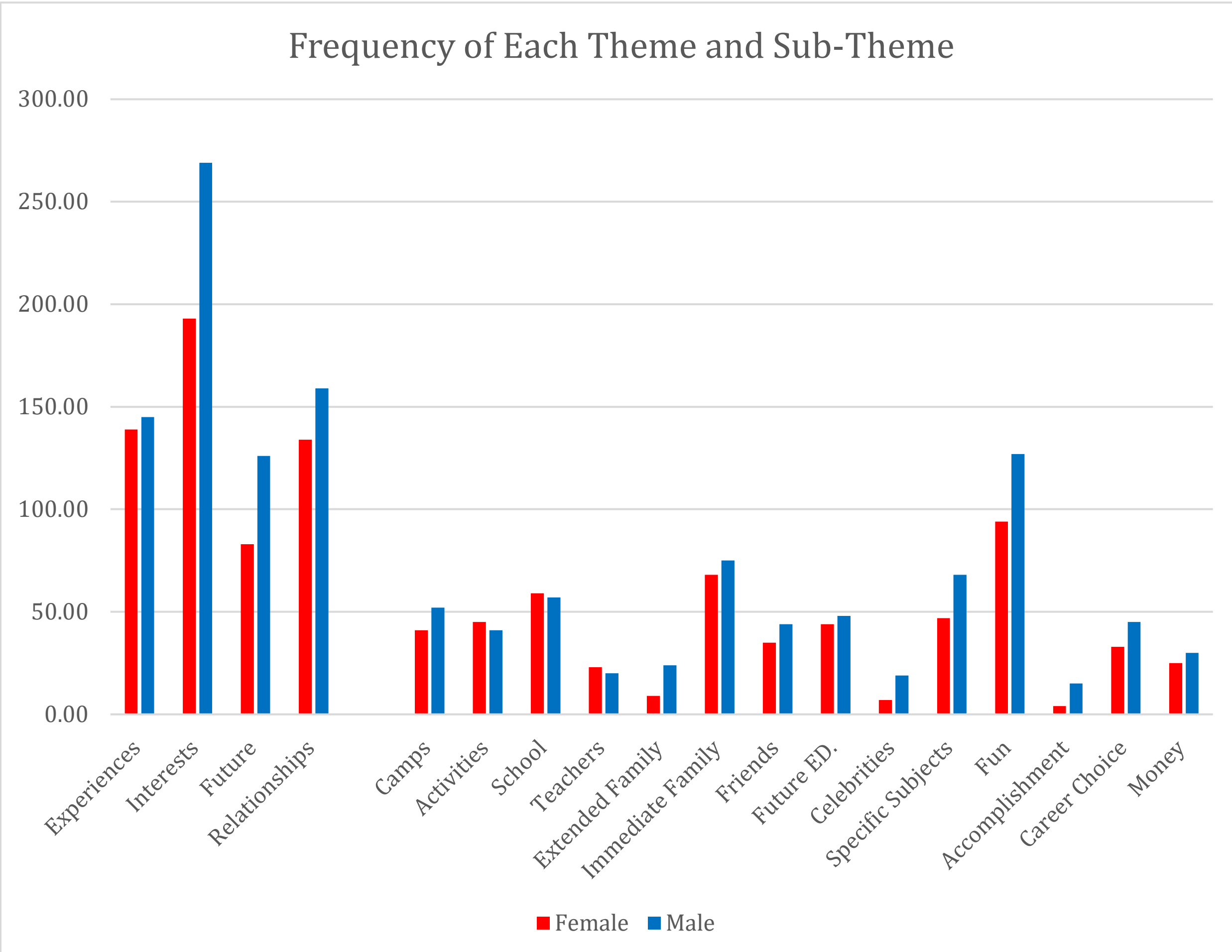

Figure 1: Bar Charts Representing the Frequency of Each Theme and Sub-theme Broken Down by Gender

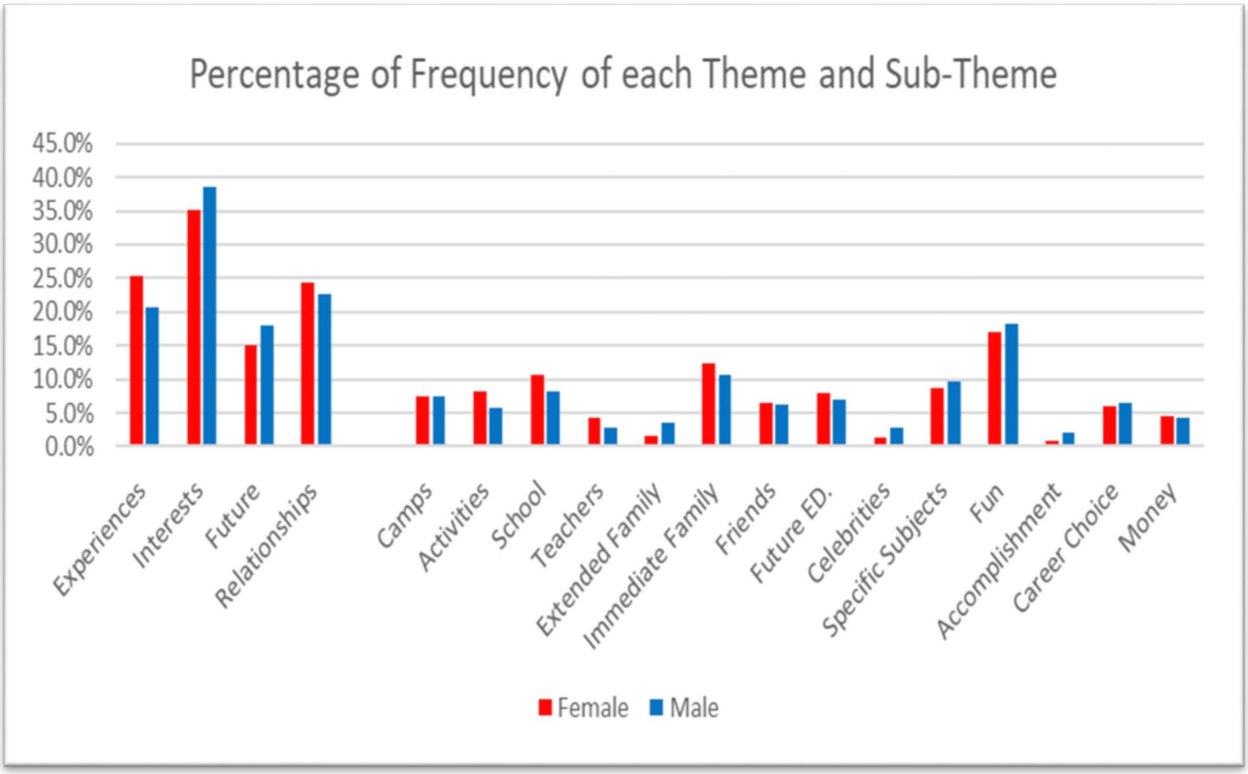

Figure 2: Bar Chart Representing the Percentage of Each Theme and Sub-theme Broken Down by Gender

Theme 1: General Interests

The theme that was most influential for both men and women was General Interest in STEM-related subjects or activities. One sub-theme under this category was Fun. Many students commented that they had fun participating in activities or events related to STEM. A quote from a male in this sub-theme is "*My experience has been fun and flavorful on the technology side for me, I like technology and I got attached to video games, if it weren't for that time where my brother showed me Star Wars Battlefront 2 for the PS2, I feel like I would've never wanted to invest into technology and actually have a career in that field.*" And a quote from a female is "*My experience with STEM fields has really been fun because there are a lot of different clubs and camps that have a lot to do with STEM and so I have had a really fun time with STEM."*

Another sub-theme under General Interest is Specific Interests. This included responses that fall under very specific topics leading students to be interested in STEM. A quote from Specific Interests is:

Male: "*Yes, I am heavily interested in technology and engineering. I am very well suited to technology and I've always wanted to be in an engineering field because I believe I can do something great.*"

Female: "*Yes I am, I have always found much interest in science and math in school and I think getting to do more hands-on stuff would make it more interesting.*"

Student responses that indicate they are interested in pursuing STEM in higher learning went under the sub-theme Future Learning which also falls under this Theme. A quote from this sub-theme is:
Male: "*Yes, I want to study in Aerospace engineering. I think that STEM would be more interesting to me if there were more hands-on activities because I am more of a visual learner.*"
Female: "*Yes, I think these specific careers are the best. There are so many to choose from, so many things to do, and you can even come up with something and adjust what it is to fit your interest.*"

A small number of students replied that Celebrities have influenced them into STEM and this would include responses to the question of "Name in order the three biggest influences on your choice of career in the future." Students' responses to this statement included:
Male: "*Frank Sinatra, Stevie Wonder, and Bruno Mars.*"
Female: "*Neil Degrass Tyson, Neil Armstrong, and Brian McIntyre*."

Theme 2: Relationships

The second theme is Relationships. This theme is a collection of student responses that lists relationships with others as an influence on their interest in STEM. This was found to be the second most influential theme for men, while being the third most influential for women. A sub-theme within this category is Immediate Family, an example of a quote from this sub-theme is:
Male: "*I have a father who teaches physics, chemistry, and has taught math in the past. I have grown up in a 'STEM environment'*."
Female: "*I am in STEM classes at school. My mom also works as a engineer for a company. My dad also fixes cars for fun."*

The next sub-theme in this category is Friends, with student responses in this sub-theme being:
Male: "*Being with my friends and being with the instructors.*"
Female: "*My memories, my experiences in life, and the people around me.*"

Another sub-theme in under Relationships is Teachers. A response under the Teacher sub-theme would be from answering this question, "Name in order the three biggest influences on your choice of career in the future."
Male: "*My math teacher last year (Mr Davis the best teacher ever) got me interested in math which is usually hated.*"
Female: "*... My teacher and how well they do the subjects but aslo my other teachers the teach me other things that I might want to go into.*"

The final sub-theme in this group is Extended Family and an example of a response would include:
Male: "*The only experience I have had with any of these fields are, talking to an airline pilot about his job and how he earned his ranking, discussing with my uncle who owns a multi-million dollar coding company, and meeting with engineers to learn about motor-vehicles.*"
Female: "*My cousin wants to be in the Marines, I love to fix things, I want to help fix planes for the Marine Corps.*"

Theme 3: Previous Experiences

The third theme was Previous Experiences with STEM or things related to STEM. This theme was found to be the second most impactful for women, and the third most impactful for men. A sub-theme under this category was Classes. A lot of students talked about how they had previously taken STEM classes which they enjoyed. A quote from this sub-theme is:
Male: "*I've taken some advanced math classes and engineering classes in school. I;ve spent some time working on automated manufacturing courses at Btech. I also like learning and reading about technology.*"
Female: "*In all my classes. I maintain a 4.0. Mainly because mathematics gives me a challenge instead of making it too easy for me. I love challenging my brain as many ways as I can*".

One other sub-theme under this category is Camps. This sub-theme includes responses from students who enjoyed previous camp experiences:
Male: "*The STEM that we did in the camp is fun and I enjoyed the different types of fun and interesting things*."
Female: "*Engineering wise, I have gone to an engineering camp in the past and just completed my second engineering camp. I am not too [good] with technology, but I can effectively draw things on paint (which is apparently supposed to be hard.*"

The last sub-them under Previous Experiences is Activities. This sub-theme is made up of students talking about activities related to STEM that they had previously enjoyed. A quote from Activities is"
Male: "*I love how I can make things to feel accomplished and hands-on activities which get me to think through things and work with others.*"
Female: "*I've been in a Science Fair. I went to this STEM program to [local] University in 6th grade. That is all so far that I've been in.*"

Theme 4: Future Opportunities

The least impactful theme overall for both men and women was Future Opportunities. This theme is made up of student responses that say their future is a relevant influence on their

interest in STEM. A sub-theme under this category is **Career Choice**, a quote from this sub-theme is:
Male: “*I want a job as a programmer so that falls under tech, so I do want a STEM job. I am interesing because I love Mine-craft.”*
Female: “*Yes, I am wanting to become an Astrophysicist. It is my love to look and study space and everything in it. I’m hoping to become the first woman on Mars.*

Another sub-theme under Future Opportunities is **Financial Opportunity**, this sub-theme contains responses such as:
Male: “*Better myself and learn about other interesting things that will help people how in the later future. Money is also a big part because I probably need to pay the bills too. Then I wnat to do something that makes me happy and something that interest me to really push me to doing all of the work.”*
Female: “*The ability to change the way people think, knowledge, and money.”*

The last sub-theme is **Potential Accomplishments**. A response from this sub-theme is:
Male: “*Here they have taught me how to think in new ways and shown me how college really works and more ways to go past the present and look into the future.*”
Female: *Yes, but not straight up STEM, just a job that includes STEM stuff because it’s fun and in basically everything.”*

The findings from the coding are summarized in figure 1 and Table 4. A discussion of those findings follows.

Table 4: Frequency of themes and sub-themes broken down by gender

Factor	Frequency in Females			Frequency in Males			Both
Main themes	Pre	Post	Both and percentage of total responses	Pre	Post	Both and percentage of total responses	Total
Experiences	75	64	139 / 25.3%	72	73	145 / 20.7%	**284**
Interests	99	94	193 / 35.2%	140	129	269 / 38.5%	**462**
Future	43	40	83 / 15.1%	66	60	126 / 18.0%	**209**
Relationships	64	70	134 / 24.4%	76	83	159 / 22.7%	**293**
Sub-themes							
Camps	20	21	41 / 7.5%	26	26	52 / 7.4%	**93**
Activities	23	22	45 / 8.2%	17	24	41 / 5.9%	**86**
School	32	27	59 / 10.7%	30	27	57 / 8.2%	**116**
Teachers	13	10	23 / 4.2%	10	10	20 / 2.9%	**43**
Extended Family	6	3	9 / 1.6%	11	13	24 / 3.4%	**33**
Immediate Family	29	39	68 / 12.4%	36	39	75 / 10.7%	**143**
Friends	16	19	35 / 6.4%	20	24	44 / 6.3%	**79**
Future ED.	22	22	44 / 8.0%	23	25	48 / 6.9%	**92**
Celebrities	3	4	7 / 1.3%	11	8	19 / 2.7%	**26**
Specific Subjects	27	20	47 / 8.6%	47	21	68 / 9.7%	**115**
Fun	46	48	94 / 17.1%	56	71	127 / 18.2%	**221**
Accomplishments	3	1	4 / 0.7%	6	9	15 / 2.1%	**19**
Career Choice	18	15	33 / 6.0%	27	18	45 / 6.4%	**78**
Money	12	13	25 / 4.6%	12	18	30 / 4.3%	**55**

This qualitative analysis reinforces the well-documented societal barriers that females face as they learn about STEM, enter STEM fields, and begin careers in STEM. This data makes it clear that females do enter into STEM fields, but when they do, they prefer to stay close to immediate family and teachers, and they value experiences. Females may not be comfortable enough to value celebrities or fun, prefering instead to focus on their ability to survive in an environment that is perceived as uncomfortable, and in some cases, hazardous.

Quantitative data analysis

Participants were measured on categories (given below), each relating to a specific STEM field within the acronym STEM (Science, Technology, Engineering, Mathematics). These categories were abstracted from statements that participants scored on a Likert-scale through the surveys that were given before and after the engineering camp. The four categories analyzed were,

1. General level of interest.
2. The presence of a role model.
3. Parental pressure to select a career.
4. Personal desire to select a career.

5. Whether their friends like science.

The Likert-scale statements from which these measures are derived are given below:

1. General level of interest

- I like my science class.
- I like to use technology for class work.
- I like activities that involve engineering.
- I like my mathematics class.

2. The presence of a role model

- I have a role model in a science career.
- I have a role model who uses technology in their career.
- I have a role model in an engineering career.
- I have a role model in a mathematics career.

3. Parental pressure to select a career

- My parents would like it if I choose a science career.
- *(No question assessed whether parents would like the participants to choose a career that uses technology)*
- My parents would like it if I choose an engineering career.
- My parents would like it if I choose a mathematics career.

4. Desire among participants to select a career

- I am interested in careers that use science.
- I am interested in careers that use technology.
- I am interested in careers that involve engineering.
- I am interested in careers that use mathematics.

5. Whether their friends like science

- My friends like science.

The average participant score for each statement (with respect to each separate field of STEM) is given in Table 5 below. All scores were measured on a Likert-scale, with 1 being 'Strongly disagree' and 5 being 'Strongly Agree'.

Table 5. Potential factors that may influence participants' interest in a STEM career.

	Average participant response			
	Science	Technology	Engineering	Mathematics
General level of interest	4.172	4.066	4.278	3.854
The presence of a role model	3.444	3.775	3.536	3.252
Parents pressure to select a career	3.576	---	3.669	3.450
Participant desire to select a career	3.927	4.166	4.066	3.669

Parental vs. Intrinsic desire to select a STEM career.

Observation of the table leads to interesting insight in the difference between 'parental pressure' and 'participant desire' to select a career in a particular field in STEM. Although this was an interaction that the researchers did not expect, a brief analysis could reveal future directions for research in the area, particularly in increasing the interest in STEM among pre-college youths in the U.S. A two-tailed t-test reveals that these are significant differences ($p < 0.001$, ---, $p < 0.001$, $p = 0.014$ for each field within STEM, respectively) displayed between the self-reported 'parental pressure' and 'participant desire'. The Pearson correlation coefficients between these two influencing variables and participants' 'general interest' are given in Table 6 as 0.250, ---, 0.389, and 0.240 for 'parental pressure to select a career' in each STEM field respectively. For the variable 'participant's desire to select a career' the correlations are 0.578, 0.624, 0.701, and 0.555, which are all markedly greater. This could indicate that pre-college participants of engineering camps display a certain pronounced level of autonomy of themselves and the choices that they make when selecting the STEM fields as their area of study. The researchers believe that further investigation between different generations of students may prove interesting. For example, do these participants, who were in the final range of the 'Generation Z' category, display more autonomy than their predesessors? Did older generations of pre-college students place more emphasis on their parents' preference of suitable career for the youths?

Correlation table between 'general interest' and several identified influencing variables

The correlation coefficients in Table 6 (below) reveal that each of the potentially influencing variables that were identified by the researchers had a sigficant correlation with 'general interest' with the exception 'My friends like science', which did not. The strongest correlations were in the category that related to the statments, "I am interested in careers that use science.", etc. Apparently there were not many participants who had a high interest in a STEM field but a low desire for a career. Nor were there many participants with a low interest in a STEM field but a strong desire to pursue a career in that field.

Table 6. Correlation coefficients between potential factors and interest in a STEM career.

	Pearson correlation coefficients				
	Science	Technology	Engineering	Mathematics	*Average*
The presence of a role model	**0.261**	**0.323**	**0.413**	**0.374**	0.343
Parental pressure to select a career	**0.250**	---	**0.389**	**0.240**	0.293
Participant's desire to select a career	**0.578**	**0.624**	**0.701**	**0.555**	0.615
"My friends like science"	0.070	-0.075	**0.150**	-0.024	0.030

The researchers believed that these potentially influencing variables would be correlated with 'general interest' and thus a right-tailed t-test was selected in order to determine if the correlations were significant. With a sample size of 151 each of the significant correlations are emphasized in bold. It was surprising that the variable "My friends like science" did not have a strong correlation with participants 'general interest' in STEM. Perhaps the participants were understanding of their friends' preferences of STEM fields and realized that these preferences should not influence their own preferences.

Gender differences in the quantitative analysis

Preliminaries: In Table 7 below we have marked the Pearson correlation coefficients which were statistically significant with boldface and an asterisk symbol, e.g. **0.888***, as opposed to 0.111. Likert-scale data is a topic of frequent controversy when it comes to drawing conclusions from correlation coefficients. With this in mind, take caution when discussing the following findings. This analysis is meant to begin discussions about the future direction of research and is not meant to serve as hard evidence for any particular thesis.

In order to generalize the responses about participants' interest in a career in each STEM field to a more general discussion about 'interest in a career in STEM', we averaged each participant's responses in the four categories of STEM in order to get an average 'interest in a career in STEM'. For example, if a participant responded that they would be interested in a career in Science/Tech/Eng./Math. on the Likert-scale with 2.0/4.0/5.0/4.0, we converted that score into 3.75 for 'interest in a career in STEM'. Table 7 (below) measures the correlation of various factors with this conglomerate 'interest in a career in STEM'.

Table 7. Correlation coefficients between various factors and the career interest in STEM.

Factor	I am interested in a career in STEM	
	Male	Female
I like my science class.	**0.588***	0.195
I have a role model in a science career.	0.110	0.194
My parents would like it if I choose a science career.	0.170	0.235
I am interested in careers that use science.	**0.400***	**0.413***
I like to use technology for class work.	0.140	**0.281***
I have a role model who uses technology in their career.	-0.139	**0.473***
I am interested in careers that use technology.	**0.326***	**0.359***
I like activities that involve engineering.	**0.259***	**0.356***
I have a role model in an engineering career.	-0.009	0.143
My parents would like it if I choose an engineering career.	0.088	0.086
I am interested in careers that involve engineering.	0.109	**0.422***
I like my mathematics class.	0.103	0.097
I have a role model in a mathematics career.	**0.329***	0.144
My parents would like it if I choose a mathematics career.	0.135	-0.030
I am interested in careers that use mathematics.	0.012	**0.494***
My friends like science.	**0.322***	0.056

Discussion about the correlation coefficients

There are a few interesting points of discussion here.

Female participants' interest in a STEM career was more correlated with technology issues than males. For example, "I have a role model who uses technology in their career." and "I like to use technology for class work.".

Another interesting fact about the correlations is the lack of correlation on the males side of things between "I am interested in careers that involve engineering/mathematics" and the conglomerate "I am interested in a career in STEM". Table 8 (see below) gives the average response for each STEM question regarding career interest in a specific field, the average conglomerate score, and the average and standard deviation of the first four questions. It is apparent that the average is almost identical to the conglomerate STEM (by the definition of conglomerate STEM). But the standard deviation reveals males have a more variant opinion on which particular STEM fields they have career interest in. Particilarly careers in technology and engineering and not mathematics.

Table 8. **Average response for interest in a STEM career along with the average and standard deviation calculated and in comparison with the conglomerate STEM average.**

	Career interest average and standard deviation vs. Conglomerate STEM						
	Science	Tech.	Eng.	Math	Average	Standard deviation	Conglomerate STEM
Male	4.047	4.337	4.174	3.64	4.050	0.258	4.049
Female	3.769	3.938	3.923	3.708	3.835	0.099	3.835

Comparison of qualitative results and quantitative results

In Table 9 (see below) lies a comparison of the qualitative and quantitative conclusions.

Table 9. The top 10 factors influencing participants interest in a STEM career

	Top 10 factors as shown by the quantitative data		Top 10 factors as shown by the qualitative data	
	Male	**Female**	**Male**	**Female**
1	I like my science class. (0.588)	I am interested in careers that use mathematics. (0.494)	Fun	Fun
2	I am interested in careers that use science. (0.400)	I have a role model who uses technology in their career. (0.473)	Immediate Family	Immediate Family
3	I have a role model in a mathematics career. (0.329)	I am interested in careers that involve engineering. (0.422)	Specific Subjects	School
4	I am interested in careers that use technology. (0.326)	I am interested in careers that use science. (0.413)	School	Specific Subjects
5	My friends like science. (0.322)	I am interested in careers that use technology. (0.359)	Camps	Activities
6	My parents would like it if I choose a science career. (0.170)	I like activities that involve engineering. (0.356)	Future Education	Future Education
7	I like to use technology for class work. (0.140)	I like to use technology for class work. (0.281)	Career Choice	Camps
8	My parents would like it if I choose a mathematics career. (0.135)	My parents would like it if I choose a science career. (0.235)	Friends	Friends
9	I have a role model in a science career. (0.110)	I like my science class. (0.195)	Activities	Career Choice
10	I am interested in careers that involve engineering. (0.109)	I have a role model in a science career. (0.194)	Financial Opportunities	Financial Opportunities

Conclusion

According to the Qualitative data collected at the camps the most important factor in determining a student's interest in STEM careers is simply a general interest in STEM subjects. This is similar to the findings of the study done by Matthew Linger which states that when it comes to interest in STEM careers "*student attitudinal variables were shown to be most* *influential*." [2] However, the results in this research showed that it is fairly typical for students to be influenced by their relationships to go into a STEM career, which is different from Linger's finding while aligning with the study done by Jungert and colleagues [3]. Our results also align with the study done by Gottfried [5], which shows that active learning in classrooms can help increase interest in STEM careers.

Within the qualitative analysis there were indications that align with the well-documented knowledge that societal barriers exist for females as they learn about STEM, enter STEM fields, and begin careers in STEM. The qualitative data makes it clear that females do enter into STEM fields, but when they do, they value different themes such as staying close to immediate family and teachers, as well as experiences. Males may have or sense more privilege to value more grandiose themes such as the future, accomplishments, extended family (as opposed to immediate family), and celebrities. Pre-college females may not be comfortable enough in the STEM space to value these same things, prefering instead to focus on their ability to survive in an environment that is perceived as uncomfortable and possibly hazardous.

The quantitative analysis of the data revealed significant correlations between 'general interest in STEM' and both [1] 'parental pressure to select a career in STEM' and [2] 'intrinsic desire to select a career in STEM'. Although both of these supplementary variables were significantly correlated it was the latter that was markedly greater indicating the possibility of stark autonomy among the K-12 students as they make choices that influence their future. Adding to that, the STEM perception of participants' friends was not significantly correlated with participants' interest in STEM.

The quantitative analysis also revealed a larger spread of interest for a career in a STEM field for males than females. Although males and females both valued careers in STEM (in general) at the same average rate, males' interest in technology careers and engineering careers much outweighed, for example, careers in math. Females valued careers in math less as well, simply not at such a more variant depth. The data also indicated that on other issues regarding technology (in addition to careers), females saw greater value. Females, for example, saw greater value in using technology in the classroom and having a role model that uses technology.

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